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# Review Performance of Transmission Lines using Static Synchronous Series Compensator

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***Abstract-*** **The power system industry is a field where there are constant changes occurs. Economic and environmental pressures force electric companies to enhance the power transfer capability of the existing transmission lines instead of constructing new ones. Besides allowing a better utilization of existing power systems capacity, FACTS controllers can control network parameters, such as magnitude of sending-end and receiving-end voltage, and active-reactive power, to improve both the transient stability performance of the system. In thesis work describe the Static synchronous series compensator device, that controls the power flow of the transmission line during sever disturbances. Basics of Static synchronous series compensator is that it does not contains bulky component like reactor and inductor so this device is more economical compare to conventional devices. And characteristic of Static synchronous series compensator is that injects or absorbs the reactance in the system and control the power. In thesis work two machine bus system with and without discrete PI controller and SSSC converter simulated in MATLAB .Simulation result obtained for selected Bus-3 in two machine power system shows that with SSSC the active-reactive powers, voltage - current compensation and damping out oscillation appropriately. In short in the power system when any disturbance occurs at that time if Static synchronous series compensator controller is connected at there so any disturbance occurs on the system may reach steady state condition very quick.**

## 1. INTRODUCTION

Series compensation is a means of controlling the power transmitted across transmission lines by altering or changing the characteristic impedance of the line. The power flow problem may be related to the length of the transmission line. The transmission line may be compensated by a fixed capacitor or inductor to meet the requirements of the transmission system. When the structure of the transmission network is considered, power flow imbalance problems arise. Inadvertent interchange occurs when the power system tie line becomes corrupted. This is because of unexpected change in load on a distribution feeder due to which the demand for power on that feeder increases or decreases. The generators are to be turned on or off to compensate for this change in load. If the generators are not activated very quickly, voltage sags or surges can occur. In such cases, controlled series compensation helps effectively.

Here in this paper a new simple concept is introduced with simultaneous operation of two machine system with SSSC converter. The SSSC is connected at bus-3 of the transmission line. The two-machine power system is simulated using MATLAB and the effect of with and without SSSC on system and in fault condition are simulated.

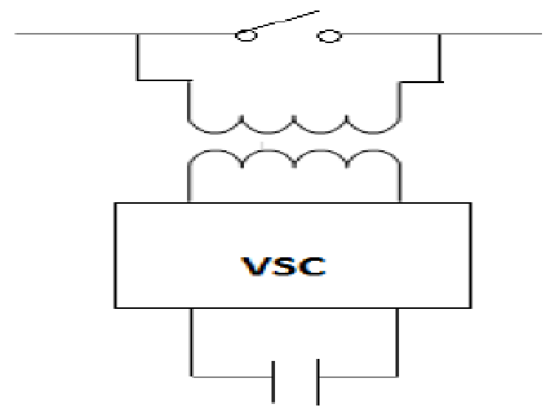


**Fig.1.1: Symbol of SSSC**

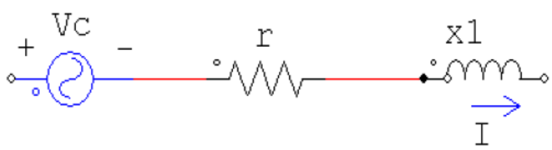


**Fig.1.2: equivalent circuit of SSSC**

The static sysnchronous series compensator (SSSC) is a series device of the Flexible AC Transmission Systems (FACTS) family using power electronics to control power flow and improve transient stability on power grids. In place of using capacitor and reactor banks, a SSSC use self-commutated voltage-source switching converters to synthesize a three-phase voltage inquadrature with the line current. The main interest is to use the SSSC for controlling flow of power (active and/or reactive) in transmission lines, whereas the SSSC is mainly recommended for damping electromechanical oscillations. Thus, the SSSC control system may be made by a compensation control loop, to accomplish its steady-state function, and by a fast response control, to act during electromechanical transients.[9][11]

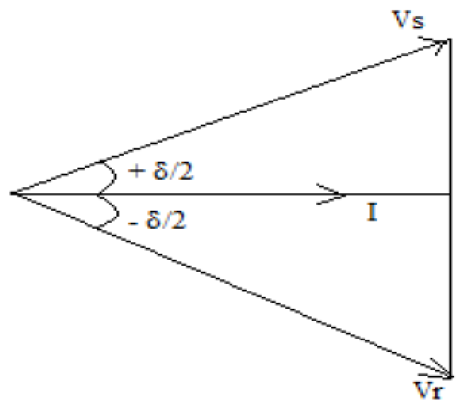


Fig.1.3: Phasor diagram

The system investigated for this paper is base on the First IEEE Benchmark Model[17] with some modifications, as depicted in Fig.3. The generator is connected to an infinite bus through a radial series compensated line. The generator is 50MVA and delivers 0.9 p.u. power to the transmission system. The excitation system is simplified with constant excitation voltage. The total line compensation degree is set to 50%. The SSSC is added downstream from the step-up transformer to replace a portion of the line compensation. The rotor shaft model is composed of six masses, which are the high-pressure (HP) turbine, the intermediate-pressure (IP) turbine, the two separate low-pressure turbines (LPA and LPB), the generator and the rotating exciter.

The detailed electrical and mechanical data are provided in [17].

### 1.1 SSSC CONTROLSYSTEM

The Static Synchronous Series Compensator (SSSC) is aseries device of the Flexible AC Transmission Systems(FACTS) family using power electronics to control power flow and improve power oscillation damping on power grids [1]. The SSSC is injects a voltage Vs in series with the transmission line where it is connected. Figure (3.1) shows single line diagram of SSSC transmission system and its control structure. As the SSSC does not use any active power source, the injected voltage must stay in quadrature with line current. By varying the magnitude of the injected voltage Vq in quadrature with current, the SSSC performs the function like a variable reactance compensator either capacitive or inductive. The variation in injected voltage is performed by means of a Voltage-Sourced Converter (VSC) that is connected on the secondary side of a coupling transformer. The Voltage-Sourced Converter (VSC) uses forced commutated power electronic devices (GTOs or IGBTs) to synthesize a voltage Vconv from a DC voltage. A capacitor connected on the DC side of the VSC acts as a DC voltage source. In this a small active power drawn from the line to keep the capacitor charged and provide to transformer, so that the injected voltage Vs is practically 90 degrees out of phase with current I. the control system block diagram Vd conv and Vq conv designated the components of converter voltage Vconv which are respectively in phase and in quadrature with current. VSC using GTO-based square-wave inverters and special interconnection transformers. In this system typically four three-level inverters are used to build a 48-step voltage waveform. Special interconnection transformers technique are used to neutralize harmonics contained in the square waves generated by individual inverters. In this Voltage- Sourced Converter (VSC), the fundamental component of voltage Vconv is proportional to the voltage Vdc . This type of inverter uses Pulse-Width Modulation (PWM) technique to synthesize a sinusoidal waveform from a DC voltage with a typical chopping frequency of a few kilohertz. Harmonics are eliminating by connecting filters at the AC side of the VSC. This type of VSC uses a fixed type of DC voltage Vdc . Voltage Vconv is varied by changing the modulation index of the PWM modulator

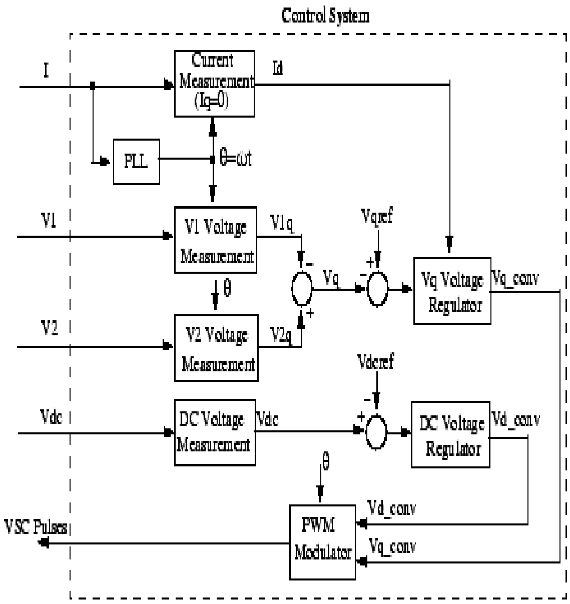


Figure 1.3 Control System Block Diagram Diagram of a SSSC..

A phase-locked loop (PLL) which synchronizes on the positive-sequence component of the current I. The output of the PLL (angle Θ=ωt) is used to compute the direct-axis and quadrature-axis components of the AC three-phase voltages and currents (labeled as Vd, Vq or Id, Iq on the diagram).Measurement systems measuring the q components of AC positive-sequence of voltages V1 and V2 (V1q and V2q) as well as the DC voltage Vdc. AC and DC voltage regulators which compute the two components of the converter voltage (Vd_conv and Vq_conv) required obtaining the desired DC voltage (Vdcref) and the injected voltage (Vqref). The Vq voltage regulator is assisted by a feed forward type regulator which predicts the Vconv voltage from the Id current measurement

## .2 TWO MACHINE MODEL OF SSSC

The two machine model has generation substations and one load centre. The generation substation (G 1) has a rating of 2100 MV A and the other substation (G2) which has a rating of 1400 MV A. The transmission lines are used to connect the load and the machines. Simulation is performed under single phase fault in the transmission line applied across the selected bus .. The SSSC is situated near the bus B2 which is in series with the transmission line as shown in the beloved figure. In the simulation the power flow control is done by utilising the SSSC in the transmission systems. The power system consists of bus 2.An output comparative analysis is done with and without SSSC in the two machine system.SSSC The two machine systems with three buses are connected using the transmission lines without SSSC. Here the transient mode is created by single phase fault at the selected bus using the transition time which is set as follows [5 6].The simulation results shows the system performances like voltage, line power, active power and reactive power. Lines L I, L2 separately.

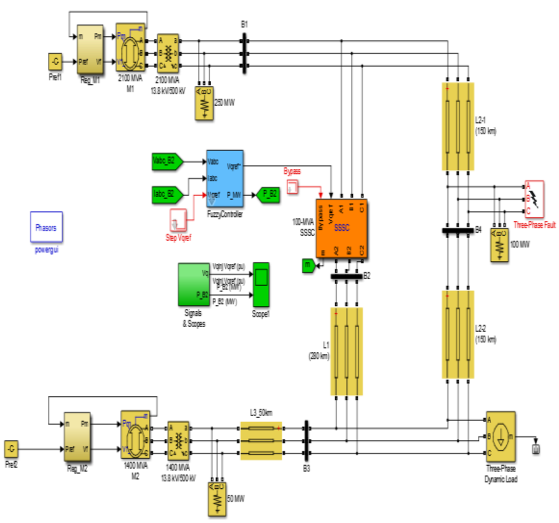

Figure2.1:Simulink diagram representation of proposed work.

## 3 RESULTS AND DISCUSSIONS

The Power regulation using a Static Synchronous Series compensator (SSSC) has been successfully implemented in the Simulink. This section deploys the results obtained and steady state and dynamic performance analysis of results obtained. For the comparative analysis a three phase fault is generated on times 1.33 and 1.5 sec using three phase fault generator. Let us first take the three phase transmission line system without SSSC. Figure (5.1) illustrates, the power obtained at bus B2 without SSSC. Figure (5.2) shows the power obtained at all the buses B1, B2, B3 and B4 without SSSC.

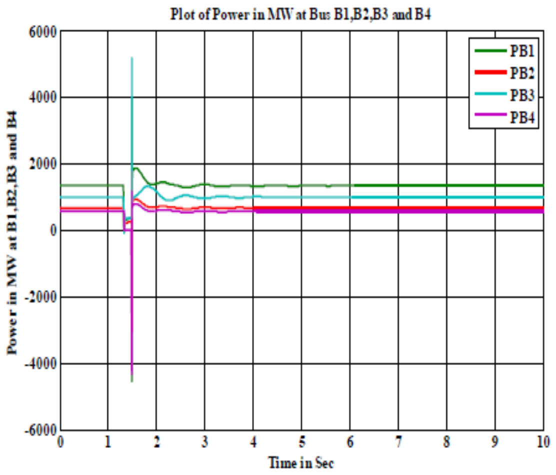


Fig.3.1 :Power obtained at all the buses B1, B2, B3 and B4 without SSSC

## 4 CONCLUSION

The advancement in the technology like homeequipments and plant equipments, demands for precession and highly regulation in the received power from energy generator through the lines, because in current scenario the equipments are very much sensitive to supply power regulation. Any kind of fluctuation either damage the costly equipment or may harm full for further used equipments. In this paper used algorithm shows an efficient solution of this problem. In this paper, a Static Synchronous Series compensator (SSSC) is has been investigated to analyze the effect of this device in controlling active and reactive powers as well as damping power system oscillations in transient mode. The SSSC setup with a source of energy in the DC link can supply or absorb the reactive and active power to or from the line. Complete Simulations have been done in MATLAB/SIMULINK environment.

## REFERENCES

[1] N. G. Hingorani and L. Gyugyi , “Understanding FACTS concepts and Technology of flexible AC transmission systems”, New York. IEEE Press, 2000.

[2] E.Acha., H Ambriz-Perez and Fuerte-Esquivel “Advanced SVC Models for Newton-Raphson Load Flow and Newton Optimal Power Flow Studies”, IEEE Transactions on Power Systems, Vol. 15(1), p.129-136, 2000.

[3] L Cai “ Robust Co-ordinated Control of FACTS Devices in Large Power Systems” a PhD Thesis, University of Duisburg, Germany, published by Logos Verlag Berlin, 2004.

[4] T. Orfanogianni and R. Bacher. “Steady-state optimization in power systems with series FACTS devices”, IEEE Transactions on Power Systems, Vol. 18(1), pp.19–26, 2003.

[5] B.H. Kim and R. Baldick. “A comparison of distributed optimal power flow algorithms”, IEEE Transactions on Power Systems, Vol. 15(2), pp. 599–604, 2000.

[6] Ishwar Lal Yadav Stability Enhancement for Transmission Lines using Static Synchronous Series Compensator International Journal of Engineering Research & Technology (IJERT) ISSN:2278-0181IJERTV4IS020811 Vol. 4 Issue 02, February-2015